CIVIL ENGINEERING RESEARCH

Feasibility Study for the Development of a Distance Learning Civil Engineering Professional Engineer Examination Refresher Course

By

Christopher J. Gallagher

A report for

CE 675 – Civil Engineering Projects

Under

Michael L. Leming

Professor

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Senior Construction Extension Specialist

Raleigh, N.C.

June 2001

DEPARTMENT OF CIVIL ENGINEERING
NORTH CAROLINA STATE UNIVERSITY

NC STATE UNIVERSITY

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1. BACKGROUND

The first known regulation to control a profession by specifying a professional license was established in 1140 A.D. when King Roger of Normandy decreed that all physicians present proof of competency before being allowed to practice medicine. After successfully completing all required academic work and a written comprehensive examination, the physician would be certified to provide medical services to the public.

In the early 1760's John Smeaton identified himself as the first "civil engineer" to distinguish himself from the "military" engineers and to clearly designate his target market. In 1852, the United States began recognizing civil engineering through the establishment of the American Society of Civil Engineers (ASCE). At that time membership in ASCE was sufficient to be recognized as a professional engineer by the courts. During the 1870's and 1880's, a number of railroad bridge failures occurred, resulting in a tremendous loss of life. Many of these failures were consistent with the evolving nature of the engineering profession that included new materials, innovative construction systems and more complex load distributions associated with longer span bridges. The public attributed the accidents to incompetent and unqualified engineers. This led to the need for legal registration of the profession in 1897.

In 1907, after much discussion, a panel of 11 ASCE members in Wyoming established the first licensing law governing the practice of engineering and surveying. After the bill was passed, written examinations began and within 2 years, 134 engineers were registered in Wyoming. Other states soon enacted their own legislation and by 1947, every state had legislation controlling the registration of engineers; however, licenses granted by one state were not recognized by another states. In 1920, the Council of State Boards for Engineering Examiners was established, and later renamed to the National Council of Engineering Examiners (NCEES) in 1967, in an attempt to promote more uniform licensing standards, national licensure, and reciprocity between the states. Although each State maintains specific individual licensing requirements, all states use the exam prepared by the NCEES to ensure each examinee is provided with the same opportunity to become licensed.

The licensing requirements for Civil Engineering include documentation of relevant work experience, personal references, and a written exam. The original licensure exam involved a 4-hour written problem solving section, which allowed the examinee to receive partial credit. Due to the non-uniform and subjective in-state grading practices, the NCEES changed the exam format. The current NCEES exam format, which began in October 2001, for a general Civil Engineering exam consists of an 4-hour multiple choice "depth" exam concentrating on one of the 5 major topic areas: geotechnical, environmental, structural, transportation, water systems; following a 4-hour multiple choice "breadth" exam that covers all areas of Civil Engineering (20% of the questions from each area).

According to data gathered from the NCEES an estimated 23,500 Civil Engineers register to take the Professional Engineer (P.E.) licensure exam each year. Approximately 400 of these examinees apply to take the exam in North Carolina. Study and preparation for the P.E. exam is a major concern for engineers seeking their license. Most P.E. candidates are practicing engineers that depend on a variety of study resources and refresher classes due to the "breadth" of the examination

The Industrial Extension Service (IES) of North Carolina State University is a provider of a high quality P.E. refresher course which is taught in a traditional live classroom format. The IES is currently considering an expansion of the P.E. refresher course by means of utilizing a suitable distance learning method to reach a larger audience while maintaining a high quality of P.E. training offerings.

In a survey done by the IES in early 2001, 31 of 32 engineers preparing for the exam purchased some sort of study material. Of these 32, 17 attended a live training course, but 28 would consider a distance learning course. Additionally, 23 of these 28 would purchase a CD-ROM and textbook distance learning course if the price and quality was competitive to a live course.

2. PROBLEM STATEMENT

Engineers seeking to obtain Professional Engineer licensure typically attend a formal classroom refresher course to help prepare for the written, qualification exam, especially those practicing abroad. Due to the flexibility to meet the constraints of practicing engineers, distance learning methods have become useful tools to assist in preparation for the Professional Engineer exam. Distance learning formats include video lectures, live online classes, and self-paced CD-ROMs. As a result of continually improving technology, distance learning methods have become more complete and affordable. The survey by IES also indicated that engineers would strongly consider distance learning methods to prepare for the P.E. exam.

As a provider of a "traditional" P.E. review course, the IES requires a quick survey of different existing distance learning delivery methods for the P.E. review. Several currently available Civil Engineering P.E. refresher distance learning courses were examined and the one "best" alternative was selected for an in-depth analysis to enable IES to offer a P.E. review course via distance learning. The in-depth subject evaluation of the selected course was completed from the point of view of a "typical" engineer preparing for the exam to identify the advantages and disadvantages of the course and to assist IES in the development of a separate, independent distance-learning course.

This report summarizes the various P.E. distance learning courses currently available, describes the selection criteria for evaluating one specific course, and discusses the advantages and disadvantages of the course. Recommendations are provided for the IES for possible implementation and further study.

3. OBJECTIVES

3.1 General

Obtaining P.E. Licensure is a defining milestone in an engineer's career. The traditional method of preparing for the written exam involves a self-directed or classroom refresher course. Self-directed studies lack structure and interaction. Traditional classroom courses lack flexibility to meet the working schedule of a typical engineer and have limited attendance due to constrained geographic location. With rapidly developing technology, several different distance learning courses become available which offers and attractive alternative to the "traditional" means of examination review.

3.2 Project Objectives

The objectives of this project are as follows:

- Identify critical factors that would make distance learning courses a desirable alternative
- Identify various representative distance learning P.E. review courses currently available
- Select a "best" course alternative
- Evaluate the selected course and identify advantages and disadvantages
- Develop break even cost evaluation for product development
- Provide feedback to the IES for future development of a distance learning course

3.3 Limitations

This report was completed with the following limitations:

- Completeness / Exhaustiveness: Not all available P.E. refresher courses were investigated. Only representative courses that were found via an internet search were considered for the initial sample of distance learning courses.
- Objectiveness: The analysis of the evaluated course is subjective and represents the view of a practicing engineer preparing for the P.E. exam. This objectiveness also applies to the identification of relative weight factors and other non-scientific criteria used for evaluation purposes.
- Subjective Ranking: All rankings were based on the perception and subjectivity of the evaluating engineer and were not a measure of the course content quality. Rankings were used to produce a relative measure of completeness, through a desirable product matrix, for future product development purposes.

4. METHODOLOGY

4.1 General

This study was conducted in three phases. Phase I consisted of identifying a sample of available distance learning courses and developing a product evaluation matrix that was based on the course description as advertised by the seller. Phase II involved selecting and performing a detailed evaluation of one course. Phase III consisted of writing a report with specific recommendations for development of a distance learning course by IES.

All phases of this report were conducted by an engineer ("the evaluator") that meets the profile of a typical examinee likely to use a distance learning course to prepare for the P.E. examination. The evaluator was a graduate student completing a Master's Degree in Civil Engineering. The evaluator had previously obtained a Bachelor's degree in Aerospace Engineering from a 4 year ABET accredited university. The student had met all experience requirements for the P.E. exam and had 6 months to prepare for the Civil Exam.

4.2 Phase I: Course Identification

Available distance learning refresher courses were identified through an extensive Internet keyword search. Additionally, the National Society of Professional Engineers (NSPE), the American Society of Civil Engineers (ASCE), and the National Council of Examiners for Engineering and Surveying (NCEES) were contacted to identify additional courses. The NCEES administers exams throughout the country but does not provide refresher courses. Contacts with NSPE and ASCE did not yield course offerings different from those already identified. A representative list of currently available P.E. Review courses is outlined in Appendix A, along with corresponding course format and contact information.

4.3 Phase II: Course Selection

The primary types of distance learning course formats are classroom, textbook, video, and CD-ROM. Each of these formats can be presented in two ways: online and offline courses. Online courses involve the use of the internet to interact with others using one of the four methods. The reference material from an online textbook course could be downloaded from the internet. Offline courses concentrate on self-paced learning that is not associated with the internet. The advantages and disadvantages of each method and format are listed in Table 1.

Table 1: Distance Learning Course Format Summary

Format	Advantage	Disadvantage
Classroom (On-line & Offline)	Face-to-Face Contact	Scheduling Difficulties
	Real Time Feedback / Assistance	Extensive Instructor Involvement
	Group Discussion Easily Conducted	Live Internet Course Expensive to Administer
		Lack of Flexibility in Attendance
		Review Course Lengths typically longer than other formats
Textbook (On-line & Offline)	Good Reference to Take Into the P.E. Exam	No Student / Teacher Interaction
	Larger Variety of Practice Problems	No Feedback
		All Material is Self-Taught with No Instruction
CD-ROM (On-line & Offline)	Ability to See the Instructor on Pre-Recorded Lesson	Minimal Feedback
	Minimal Instructor Involvement with Course after Initial Development	Minimal Student / Teacher Interaction
	Printable Text Available for Reference during P.E. Exam	Limited Variety of Problems
	High Quality Visual Aids	
	Lesson Topic Instruction Quick and Easy to Repeat	
Video (Offline)	Ability to See Instructor	No Feedback
	Minimal Instructor Involvement with Course after Initial Development	No Student / Teacher Interaction
		No Written Text or Example Problems Provided
		Review of Specific Topics are Slow to Repeat

The online, live classroom environment is most effective in allowing people to interact and discuss problems and solutions. This format is costly to produce over the internet and requires specific scheduling by students. The textbook is a very common method of review and provides a useful reference that can be brought into the exam. Use of a textbook is designed for self-paced learning without the benefit of personnel interaction. CD-ROM and video courses combine the advantages and disadvantages of classroom and textbook distance learning formats into a useful and effective course. The advantages of each method and delivery mechanism were integrated into a more formal evaluation procedure to select a "best" course to meet IES requirements. Full discussion of the evaluation procedure is provided in Chapter 5.

4.4 Phase II: Course Evaluation

A comparison chart was first developed to summarize the advantages and disadvantages of each module in the evaluated course and create a set of "ideal" course characteristics. Several references were used to identify key success factors that contribute to the development of an effective learning environment. A hypothetical "ideal" learning environment was developed by combining these key factors into a single comparison chart. The effectiveness of any training course is dependent on the individual needs of the student, and the proper implementation and combination of these keys factors should improve the learning capability of an average student.

A value of 100% was assigned to each factor to establish a baseline value for comparison. Each key factor was assigned a weight factor of importance based on the similarities between the references and the level of importance as based on the evaluator's judgement. These weight factors were used to determine an overall rating of the individual modules compared to a hypothetical "ideal" learning environment. The completed comparison chart is shown in Appendix B.

Following the creation of the "ideal" course characteristics chart shown in Appendix B, the evaluator enrolled and completed individual sections of the course. Upon completion of each individual module, the positives and negatives of each section were compared with the ideal

course characteristics in Appendix B, and a rating was assigned to each characteristic as compared to the pre-determined baseline. The individual module ratings were based on how effectively the module met or did not meet the selection criteria. After completing the matrix for each module, the individual ratings were multiplied by its weight factor and combined to determine and overall rating for the course.

After evaluating each module and completing the pre and post-exams offered with the course, recommendations were developed which identified existing and additional topical coverage areas, time to cover each of the respective topic areas, presentation format, and types of example problems to present. In addition, modifications appropriate for development of a new course offering by IES, including the incorporation of new technologies, were recommended.

5. COURSE SELECTION CRITERIA

5.1 General

Course selection criteria were established based on on-line marketing information provided by the product seller. A total of 7 common product features were identified and are summarized in Appendix C. Each feature was assigned a individual weight factor based on perceived student needs and the requirements set forth by the IES. The combination of all seven factors gave a total possible 100 points. A full discussion of each contributing factor is provided in sections 5.2 through 5.8.

5.2 Course Format

The Industrial Extension Service desires to develop a new course that captures the quality of their live course and instructors, yet is self-sustaining in the sense that it requires minimal post-development instructor involvement. Presentation format is a critical factor in determining which course to select. A live Internet course most closely represents a classroom environment and allows student interaction; however, it would require continuous instructor involvement and is more costly than other methods. There are numerous stand-alone textbooks available which have saturated the marketplace and made it difficult for a new book to have a competitive advantage over others.

Both the on-line and offline CD-ROM and video based formats were the most applicable to this project. Since the Industrial Extension Service currently produces a video based refresher course which covers some of the major topics on the P.E., the on-line CD-ROM format was selected as the most appropriate due to its lower cost and flexible scheduling. Based on the importance of selecting the correct format, this factor was assigned a maximum weight factor of 20 out of 100.

5.3 Availability of Instructor

Inevitably questions arise from difficult and unclear concepts, or details that were not addressed in the lecture. The type of assistance and the availability of the instructor became the second factor of importance. Only classroom or video-based courses that provide a means of interaction between the students and instructor, through either email, telephone, or face-to-face contact, were considered acceptable courses. This factor was considered critical in the effectiveness of a distance learning course and was also assigned a maximum weight factor of 20 out of 100.

5.4 Class Duration

Typically, individuals preparing for the P.E. exam through the use of a classroom based refresher course begin reviewing material a few months prior to the exam date. Self directed refresher courses are often completed in less time than a structured class. Designing a new structured course, but on a self-paced level, caused the course completion time to be the third factor of importance. The time required to complete any course is partially dependent on the individual and on the designed course length. Courses evaluated in this study ranged from 50 hours of self-paced instruction to 6 months of interactive class work. Since the typical individual who will be completing the review course will be maintaining a full time job, ideally, the shorter amount of time required for review, the more likely the individual is to choose a specific course. With a wide range of available course durations, this factor was assigned a maximum weight factor of 15 out of 100.

5.5 Instructor's Knowledge of Specific Exam Content

Before selecting any course of study, it is important to identify the instructor's qualifications. Some instructor's are unfamiliar with the exact contents of the P.E. exam or offer only selected areas of instruction. All programs and vendors that produced a comprehensive, self-sustaining P.E. refresher course were consider for the evaluation. Additionally, a program that was sponsored by a key engineering organization or a recognized educational institute were

considered more favorable than non-sponsored programs due to the likelihood of the organization being more familiar with the current P.E. exam content and format. This factor was assigned a maximum weight factor of 15 out of 100.

5.6 Cost

Of the courses identified, the costs ranged from $200 for a single instructional area to $2500 for an on-line, interactive, comprehensive refresher course. The cost was a factor in selection based on the products marketing potential. The content of the evaluated product could be compared to the overall cost to determine proper pricing for a similar course. The cost factor was assigned a maximum weight factor of 10 out of 100.

5.7 Miscellaneous Factors

Appendix C summarizes the critical factors and weight factors used for selecting the evaluated course. Aside from the previously discussed factors, several other non-critical selection factors were identified for this study. The number of lessons provided was considered to be less important than the total time required to complete the course; however a sufficient number of lessons were required to fully cover the major topic areas. This caused the course duration to be weighted 10 out of 100 points. Finally, the retake guarantee would typically be a critical selection factor if cost was more highly rated. The ability to retake the course was not weighted heavily (10 out of 100).

5.8 Selected Course

The course offered by Keepsmart Engineering, in coordination with ASCE, was selected to be the most applicable to this study and received a combined score of 86 out of 100. The selected course combines both a CD-ROM and Internet format and is designed to be a 7 module, 50-hour self-paced program covering each major Civil Engineering topic.

After purchasing the course, the evaluator was provided with immediate access to an online version of the course. The course software was then shipped overnight to the evaluator. The CD-ROM combines both an audio and video instructional presentation, whereas the online version contains only audio clips due to the large bandwidth required for video. In both instances, help is available for each module through a central point of contact at Keepsmart Engineering via email. A database of questions is maintained at Keepsmart Engineering, and any new questions are forwarded to the instructor for evaluation. Questions are then answered via email back to the individual. Feedback time for a common question is between 30 minutes and 24 hours. In the event the student requests to discuss the topic or question with the instructor, Keepsmart Engineering contacts the instructor to obtain approval for one-on-one contact. However, since the instructors are full time engineers, availability to talk with them personally is dependent on their schedule.

6. COURSE EXAMINATION

6.1 General Course Overview

The selected course was divided into 7 different modules that cover the major topic areas in Civil Engineering. Table 2 lists all the major topic areas covered by the course. Each module consisted of four sections: a pre-exam, a demonstration problem, a practice problem, and a post-exam. The course moves through each section of the module, although the student has the option to go directly to any specific module.

Table 2: Course Content Summary

Course Module	Content			
Economics	Present Cost	Annual Cost	Internal Rate of Return	Effective Interest Rate
	Project w/ Perpetual Life	Depreciation and Taxes	Ranking Alternative Projects	
Geotechnical	Soil Classification	Phase Relationships	Effective Stress & Stress Distribution	Consolidation
	Strength & Bearing Capacity	Earth Retaining Structures	Piles	Seepage
Hydraulics and Hydrology	Hydrostatics	Closed Circuits	Friction Losses	Minor Form Losses
	Rainfall Runoff	Momentum	Specific Energy	Manning Equation
Structures	Steel Beams & Trusses	Beams/Columns	Concrete Arches & Columns	Concrete beams
Sanitary and Environmental	Water Demand	Water Softening	Coagulation & Flocculation	Ground Water Problems
	Trickling Filters	Stream Purification	Sludge Digestion	Land Filling
Transportation	Traffic Volumes	Traffic Signal Warrants	Freeway Interchanges	Freeway Analysis
	Timing & Signalized Intersections	Vehicle Speeds	Accident Reconstruction	Trip Generation & Queuing
Surveying	Circular & Vertical Curves	Spiral Curves	Grade Separation	Earthwork

Prior to beginning each module, the evaluator completed an on-line pre-exam with the use of only reference 8. The pre-exam was only accessible through the online webpage and was printed through the use of the "print screen" option. The evaluator's pre-exam answers were entered into the Keepsmart Engineering database and used to establish a subject matter baseline for the evaluator and ultimately measure the course effectiveness for that student.

After completing the pre-exam, each module presented a demonstration problem focusing on the specific area. Typically these specific topic areas were similar to the questions on the pre-exam. Each demonstration problems was viewed and printed through Adobe Acrobat Reader. The solutions for each module were printed as a whole with the "printable solutions" option, or could be printed individually from the specific subject demo problem screen. Each problem consisted of several questions, each of which were multiple choice, and contained embedded hypertext, for example "manometer", "atmospheric pressure" and "head" as shown in Figure 1, that provided the user with definitions and equations for key words within the problem.

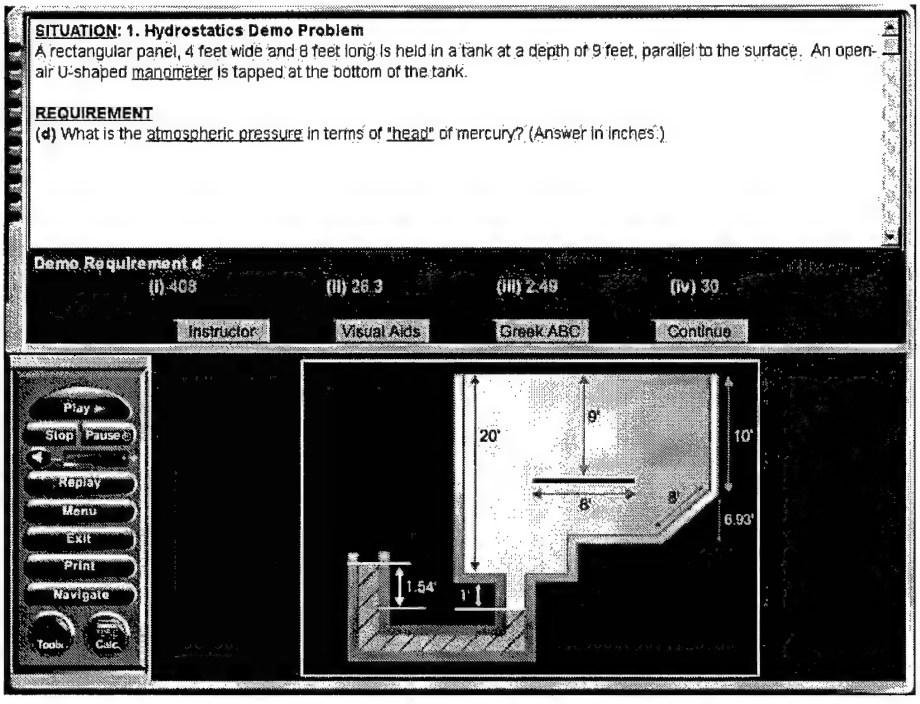

Figure 1: Example Demonstration Problem Screen

During the demonstration problem, the evaluator had the option to activate an instructor recording to have the "instructor" explain the basic concept behind the problem, the problem itself, or a specific problem requirement / question. In the CD-ROM course, a small screen appeared with a video clip of the instructor explaining the requested information. The online course only provided audio of the instructor's voice.

The third part of the module was the practice problem. Each module contained one practice problem for each major topic area. Each problem contained multiple questions with each successive questions depending on the previous one. The practice problem was basically a duplication of the demonstration problem, but with the numerical values changed as shown by comparing Figures 1 & 2. There was no instruction provided to complete the practice problem. The instructor non-quantitatively indicated, via audio, whether the evaluator had selected the correct or incorrect answer. The evaluator was continued selecting answers until the correct answer was chosen.

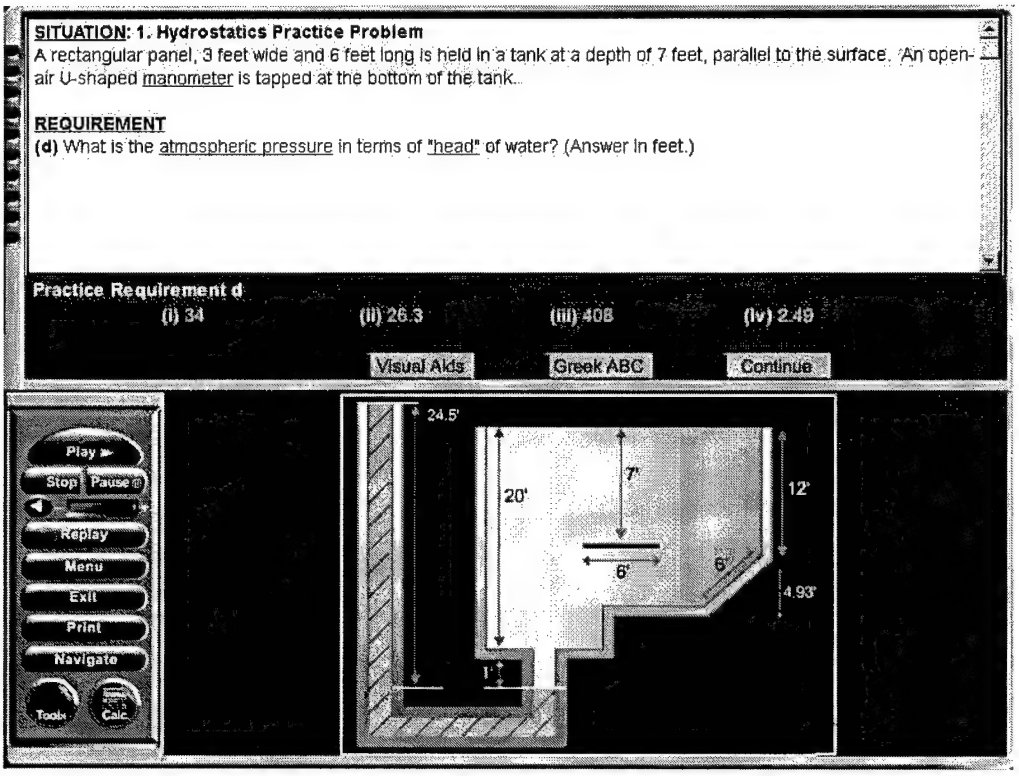

Figure 2: Example Practice Problem Screen

The post-exam followed the same format as the pre-exam and contained the same problem structure as shown in the demonstration and practice problems. The difference with the post-exam was that only one question was asked from each different section within the module; however this question was identical conceptually to the practice and demonstration problems.

After completing the online post-exam, the questions were corrected within seconds and marked as correct (with a green checkmark) or incorrect (with a red x). The final results included the percent correct on the post-exam and percent improvement from the pre-exam to the post-exam. Correct answers to incorrect problems were not provided. An email was sent to the account on file stating the evaluator had successfully completed the given section with the indicated percentage correct.

The evaluated course was heavily problem based with supporting theory added as necessary. The course was designed for the typical engineer preparing for the P.E. and geared towards individuals with a technical background, ideally with an undergraduate engineering degree. Although non-technical individuals could successfully complete the course, it would probably require the use of additional resources outside the individual refresher program. The program course was designed as a review course and not intended to provide initial instruction

6.2 Screen Layout

Each module contained a basic problem screen and was separated into three sections: problem statement, visual aids, and control menu. Figures 1 & 2 show an example problem screen with the problem statement in the top window, the visual aids on the lower right, and the control menu on the lower left.

6.2.1 Problem Statement

The problem statement screen listed the general situation, the solution requirement, four multiple-choice answers, and four command options. Within the problem requirements were

hypertext links that displayed the requested information in the visual aids section. The command options that were provided allowed the user to activate the instructor video recording (or audio in the online version), view additional visual aids that were related to the specific module, display the Greek Alphabet, or continue onto the next problem.

6.2.2 Visual Aids

The purpose of this screen was to display supporting information for the problem. This information included basic equations relating to the subject topic, associated tables and graphs, and video clips of tests that were performed to determine certain parameters within the problem (i.e. how to conduct a plasticity test). Additionally, when the problem was first introduced, the visual aids screen displayed a free body diagram or a sketch of the problem situation as shown in Figure 1.

6.2.3 Control Menu

The control menu provided the user with a means to navigate through the entire program, and access additional information about the resources used to develop the specific topic area. A list of resources and comprehensive glossary was accessed through the "tools" option. Additionally, one available tool was an internal scientific calculator, which was capable of performing very basic operations. Another key option was the control of the video instructor. The evaluator could start, stop, and replay the video clips; however, once the video clip began it could not be partially rewound. This caused the evaluator to replay the entire video clip even if only part of the instruction was required.

6.3 Individual Module Evaluation Ratings

The comparison charts in Appendix B-1 and B-2 summarize the ratings assigned to each individual module and is divided into delivery and content related factors. Table 3 summarizes the combinations of all 7 modules weight factors for a specific rating factor and shows the average value of each factor for the entire course. The entire course received a rating of 76.6%.

The factors associated with the content of the course module are shown in italics, whereas delivery related factors are in regular text.

Table 3: Civil Engineering Review Course Evaluation

Form / Delivery Method / Content	Weight Factor	Baseline	Entire CE Review Course
Face-to-Face contact between students and teachers	6	100%	50%
Instructor speaks clearly and slowly	6	100%	100%
Fundamental concepts reviewed and explained	*6*	*100%*	*100%*
Effective use of visual aids (informative, legible, subject applicability)	6	100%	100%
Technical terms clearly identified	6	100%	100%
Course Content is comprehensive	*5*	*100%*	*91.4%*
Course covers all major topic areas	*5*	*100%*	*95.7%*
Course ties all major topic areas together	*5*	*100%*	*100%*
Feedback is analytical, suggestive, and timely (not just provisions of the right answers)	5	100%	65.7%
Ability to see and hear the instructor	4	100%	80%
Active participation by the learner vice passively listening to lectures	4	100%	50%
Written text provided that supplements course lectures	4	100%	80%
Hyperlinks provided for more topic information	4	100%	100%
Internal emphasis focusing on how instructional material relates to everyday reality	*4*	*100%*	*50%*
Concepts are presented in a variety of contexts and expressed in a variety of ways	*4*	*100%*	*50%*
Provides students with the ability to verbally express ideas and discuss problems with peers and teachers	3	100%	20%
Promote Group learning (Interaction with other students)	3	100%	0%
Course provides challenging, but attainable learning tasks	*3*	*100%*	*100%*
Problem presents more information than necessary to allow student decide which information is relevant	*3*	*100%*	*82.9%*
Course material presented in a manner that increases students self confidence (start with simple concepts before introducing new ones)	*3*	*100%*	*100%*
Problems require students to make logical assumptions	3	100%	100%
Problems require students to think critically and analyze information	3	100%	100%
Student provided with a "hands-on" model	2	100%	0%
Student discussion of relevant P.E. experiences	2	100%	0%
Introduction poses questions that are interesting and familiar to the student	1	100%	50%

The majority of the factors listed in Appendix B concentrate on the delivery method used to present the material. Several factors concentrate on the individual content for each module. However, for the delivery method factors in plain text, the ratings are relatively consistent across all seven modules since the types of visuals, tools, resources, and screen layout were the same for each module. The only major change in presentation style was the individual instructor's ability to accurately and effectively convey the topic to the student. The individual content factors will be discussed in section 6.4.3 through 6.4.9.

Referring to Appendix B-1 and B-2, a hypothetical "ideal" classroom was designed to be used as a baseline for comparison with the evaluated course. The "ideal" factors were assigned a value of 100%. In many instances, key factors for a distance-learning, self-paced class (specifically this CD-ROM training course) were assigned a score of 0% due to the manner in which these factors were selected. For example, some of the factors that received an effectiveness rating of 0% included the ability to promote group learning, the use of a "hands-on" model, and the opportunity to share personal experiences with similar problems. Although all the factors were considered in rating the course, they are more applicable to a "new instruction" course and not directly applicable to a distance learning "review" type course.

The ability to have face-to-face contact between students and instructors was assigned a value of 50%. In an "ideal" classroom, the student is able to ask questions of the instructor and receive immediate feedback. In this course, the evaluator was able to "see" the instructor in the video presentations, which made it easier to follow the instruction.

During the course, the evaluator had the option to be actively involved in the instructions by working practice problems along with the instruction from the demonstration problem. However, the evaluator had the option to passively listen to the instructor and not actively participate. As a result, the active participation in class factor for this course was assigned a constant value of 50% for each module since the evaluator was not required to participate during the instruction. There were no outside homework assignments required to complete the course.

Finally, the course is designed to be self-paced which eliminates the ability to verbally express ideas and discuss problems with peers and coworkers. However the factor was assigned a rating of 20% since the typical engineer studying for the P.E. has the ability to discuss the problems with other engineers in the work place.

6.4 Course and Module Impressions

Overall the course appears to be an excellent tool in preparing for the Civil Professional Engineer exam. The entire course was presented in a very professional manner, with the proper emphasis given to each of the seven major topic areas. Each module contained an animated introduction slide, which provided a good initial impression of the quality and time involved in developing each module. The cost for the course was reasonable for the amount and quality of instructional content included. Based on the previously identified selection criteria, this course met all the selection criteria, and after evaluation, met the expectations of the evaluator.

6.4.1 Overall Advantages

The layout of the course was very user friendly. The main problem screens were easy to navigate through and provided all the necessary information to complete each problem through the use of hyperlinks and the available tools; therefore no additional reference material was needed to successfully complete the problems. All required tables and figures were included within the program itself.

The course instruction was presented in a clear and concise manner, which made it easy to review the topic even with the absence of the physical instructor. Problems were presented in a logical manner, and few questions arose that were not covered by another section of the module. In a few instances, the evaluator identified questions from unclear concepts during the theory discussion, but no questions arose as to the intent of the review problems or how to go about solving the problem. When a clarification was needed, answers were obtained from either Keepsmart Engineering or the instructor within 48 hours.

The ability to print out the solution to each demonstration problem was a great reference to be used during the P.E. exam. Additionally, the internal, scientific calculator provided a good resource and tool in calculating problems and allows the program to be a self-sufficient training course. The calculator contained specific help options that identified and defined each key. A final benefit of this course was the email message that indicated the evaluator's completion of a specific module. This email provided existing registered Professional Engineers with credit for annual continuing education requirements.

6.4.2 Overall Disadvantages

To assist the IES in creating a separate, competitive program, several areas were identified in the evaluated course that would improve the course and add greater benefit future students. These areas were identified based on the ideal learning environment factors discussed in section 5.3.

First, as identified in course evaluation factors, the "ideal" learning environment would include a text associated with the course material. A printable solutions option for the demonstration problems was available with this program through the use of Adobe Acrobat(C). The problem was with printing a demonstration or practice problem to be used as a worksheet for completing the problem. In this case, the page could not be formatted prior to printing and the problem printed on a single page. As a result, problems with multiple questions were printed in a very small font size. This made it difficult to read and did not provide sufficient room to work out the individual questions. As an improvement, the problem should be able to be formatted as necessary to increase the font size and provide sufficient room to complete all question calculations.

One measure of an ideal classroom is whether the concepts are presented in a variety of contexts and expressed in a variety of ways. The problems presented in this course were repetitive. As previously mentioned, all four problems (pre-exam, demonstration, practice, and post-exam) were formatted in exactly the same manner with the exception of the actual values within the problem. The course teaches how to complete a specific type of problem and did not

expose the evaluator to other methods of presenting the problem. Additional practice problems should be added as a supplement to the course, which covers the same topics already presented, but provides the evaluator with the ability to see a problem presented in a different manner.

As indicated in Table 3, in order to be effective, feedback during a course needs to be analytical, suggestive, and timely. Typically, the response to an incorrect answer was that it was wrong and did not indicate why it was wrong. Similarly, correct answers were not quantified, only indicated as correct. For example, in an economics question involving the comparison of two or more companies, the question asked which company had the highest rate of return. The answers were company A or B. When the correct answer was selected, the instructor responded with an audio clip like, "Correct, Company A has the higher rate of return." The actual calculated rate of return should be provided to serve as confirmation that the problem was calculated correctly and not just arrived at by chance. The audio clip should respond like, "Correct, the ROI for Company A is 18%." Similarly, if the answer is incorrect, the audio clip should explain why that answer is not the correct answer.

In order to understand the topics being presented, each term needs to be clearly defined, or the ability to define the term should be made available to the student. This course provides an extensive technical library that is accessed via hyperlinks throughout the problem text. Although the definitions listed are very helpful, there is no search engine included that allows the student to look-up specific terms. As a convenience to the student, the ability to enter a technical term and obtain its definition is not necessary but would be an added benefit to the program.

Finally, once the video instructor is activated, the evaluator was required to listen to the entire pre-recorded lecture segment, which could last between 10 and 60 seconds. There was not an option to partially rewind or fast-forward the instruction. This proved to be an inconvenience when only a section of the instruction was needed to clarify the problem for the student.

6.4.3 Economics

Although there is not a specific economics section on the new breadth and depth Civil P.E. Exam, the concepts are important to understand and may appear within one of the five major Civil Engineering categories. The economics module is divided into 7 separate sections that cover the topic areas shown in Table 2. Fundamental concept coverage, feedback, how material relates to everyday reality, and concepts being presented in a variety of manners are all evaluation factors that address individual module content.

The feedback for economics received a rating of 50% since many of the answers were not quantified by providing the student with the correct number. Additionally, the module did not explain why the other answers were are incorrect, which makes it difficult to determine where the error in the calculations occurred.

How the economics problems related to reality received a rating of 50% primarily because each topic was presented as a textbook problem with little reference to how it applies to a real-life situation. Additionally, each topic was presented in one manner. There was no variety between demo and practice problems. Finally, each of the topics in the module presented only the information necessary to solve the problems which eliminated the need for the student to decipher the important values. As a result, this area was given a value of 80%.

6.4.4 Geotechnical

The entire Geotechnical topic was covered very extensively and thoroughly. Under the Soil Classification section, there was a detailed video clip of how to perform a liquid and plastic limit tests. This video was informative but added little value to understanding how to complete the problems. Conversely, the video clip provided in the consolidation section was very beneficial in understanding the consolidation theory. It clearly defined the theory and demonstrated its application.

The individual values assigned to the Geotechnical evaluation factors were higher than the economics section. Compared to available reference material, the topic appeared to completely comprehensive and covered all major topic areas. Additionally, the feedback on correct and incorrect answers was more qualitative and provided the actual value corresponding to the answer which caused the feedback rating to be higher at 70%. This value was not assigned a 100% value since 100% represents real-time feedback from an instructor in a classroom setting. Finally, the problems contained information in excess of that necessary to complete the problem which caused this factor to be 100%.

6.4.5 Hydrology and Hydraulics

The module provided an extensive review of the topic. The sections discussing closed circuit, friction loss, minor losses, and momentum were very well integrated. However, the module needed to include more discussion on pumps and turbines, reservoir sizing, and Bernoulli's equation. As a result, the comprehensiveness of the course only received an 80%. The rest of the individual evaluation scores were similar to the Geotechnical section with the exception of problem information. This factor received a value of 80% because no excess information was provided in the problem.

6.4.6 Structures

Structures is a very broad topic and difficult to cover all the specific aspects of structural design in a short refresher course. The module covered 5 major topics, but should have included several additional topics that are discussed in section 7.0. As a result, the comprehensiveness of the module received a rating of 70%. The other rating factors were identical to the Hydraulics and hydrology module.

During the instruction of this module, the instructor discussed the process behind solving the problem rather than immediately discussing which formulas to use for the problem solution. This brief process introduction was very beneficial in understanding how to approach each problem. The drawback to this module was the lack of requirements for each problem. Many of

the demonstration problems only contained 3 requirements with only 1 of those requirements being asked in the practice problem.

6.4.7 Environmental and Sanitation

This module was very comprehensive and covered all the major topic areas completely which caused the comprehensiveness factor to be assigned a value of 90%. The ratings for this module were the same as economics except the comprehensiveness factor. The benefit of this module over the others was that it clearly quantified correct and incorrect answers so the evaluator could determine where the mistake was made in the calculations.

6.4.8 Transportation

Thorough coverage of all topic areas with the exception of specific roadway design which resulted in a rating of 90% for the module comprehensiveness. Additionally, the feedback given for each problem, as well as the remainder of the evaluation factor ratings, mirrored the Economics section in that it did not quantify "yes", "no", "true", and "false" answers. If answered incorrectly, there was no explanation at why that was the incorrect answer. This module also contained several video clips that showed how traffic lights were timed, how lane sizing was accomplished, and how an Automatic Traffic Recorder functioned. Although informative, these video clips were not necessary to fully understand these concepts.

6.4.9 Surveying

Although there is not an afternoon section on the P.E. exam dedicated to surveying, the concepts in this module are incorporated into the 5 main topic areas. This entire module was extremely comprehensive and provided the best feedback of any of the other 6 modules. When an answer was incorrect, the instructor indicated where in the calculation the error had most likely occurred. Additionally, each correct and incorrect answer was quantified which resulted in the feedback factor being assigned a rating of 80%. The remaining evaluation factors received ratings identical to the Geotechnical module.

7. COST ANALYSIS

7.1 General

A break even analysis was completed to determine whether the creation of a competitive product will be cost beneficial to the IES. According to the NCEES, an estimated 12,000 engineers take the Civil P.E. Exam annually. This break even analysis assumes a linear sales growth to achieve 10% and 20% market shares in the U.S. market for distance learning products of this type.

7.2 Product Costs

The cost to develop a new course includes both fixed and variable costs. Fixed costs include all costs that must be paid regardless of the amount of product sold. In this analysis, all the production and marketing costs were considered fixed costs. Variable costs are dependent on the number of units sold and are typically linear in nature. The combination of fixed and variable costs are added to obtain the total cost of the product. Table 4 summarizes the fixed and variable costs for this study. Most of the costs are self explanatory.

A previous analysis suggests that the addition of an "on-demand" instructor would be an attractive service to students purchasing the IES product. For this, the cost of a dedicated help line was included at an assumed rate of $150/hour. Additionally, only 30 minutes of questions was estimated for every 10 units sold. This equated to $7.50 for product support per unit sold. The waste factor takes into account damage CDs and errors in reproducing both the text and CD information.

Table 4: Total IES Product Costs

	Quantity	Unit	Unit Price	Total Price
Fixed Costs:				
Development				
IES Media Designers	5000	hrs	$23	$115,000
IES Instructor Development	5000	Hrs	$40	$200,000
IES Project Management	80	hrs	$40	$3,200
Web Page Development	40	hrs	$25	$1,000
Marketing				
Develop Printed materials	80	hrs	$25	$2,000
Print and mail Postcards	24,000	Ea	$0.50	$12,000
Total Fixed Costs:				**$333,200**
Variable Costs:				
Per Unit Costs:				
Compact Discs	2	Ea	$2.00	$4
Computer Copying Time	0.5	hours	$25	$13
Shipping	1	LS	$10	$10
Admin Support	0.5	hrs	$14	$7
Dedicated Help Line	0.5	hrs	$15	$8
(10 units = 0.5 hours help)				
Printed text Reproduction	1	LS	$10	$10
Waste (10%)	1	LS	$1	$1
Instructor Royalties (1%)	1	LS	$1	$1
Total Variable Costs / Unit				**$53**

7.3 Break Even Analysis

There is evidence that engineers preparing to take the P.E. examination are moderately sensitive to course prices. Based on a survey conducted by IES, 20 out of 27 engineers would pay up to $500 for a refresher course. This analysis considered selling prices between $200 and $500. As shown in Figure 3, if the selling price was $300, the IES would need to sell approximately 1350 units before making a profit. Similarly, at $400, the IES would only need to sell 950 units break even.

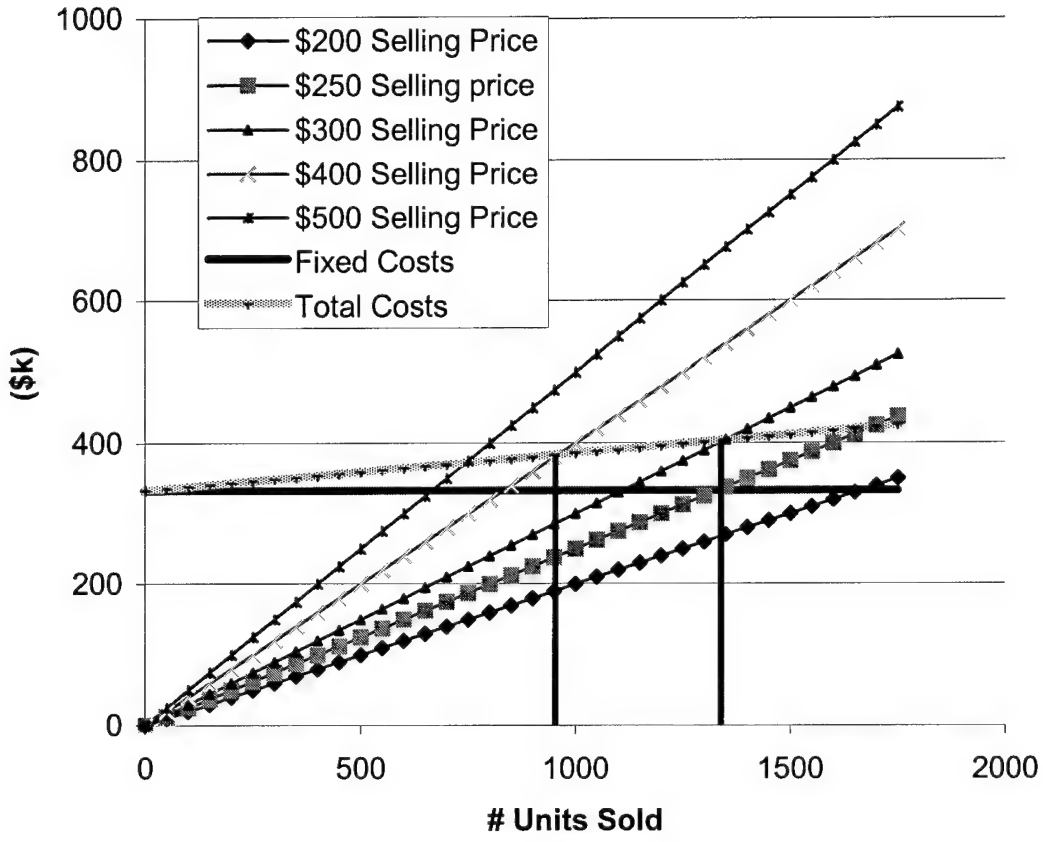

Figure 3: IES Break Even Analysis

The target market for the product is nationwide with the potential to reach internationally. Data from NCEES indicates that in 2001, the number of North American engineers applying for the exam was approximately 12,000. This represented an increase of almost 1,000 applicants throughout the country from last year. This growth is expected to continue in the future.

The IES product is likely to obtain a small share of the market shortly after launch. This share is likely to increase with time. Two assumptions are made in the market share growth. First, a pessimistic growth rate of 2% a year for 5 years will yield a total market share of 10% and would require 2.0 years before IES would make a profit as shown in Figure 4. The second

assumption is an optimistic growth rate of 4% a year for 5 years to obtain a total market share of 20%. In this case, the break even point would occur at 2.8 years as shown in Figure 5. In both instances, a constant market of 12,000 engineers nationwide and a selling price of $300/unit was considered.

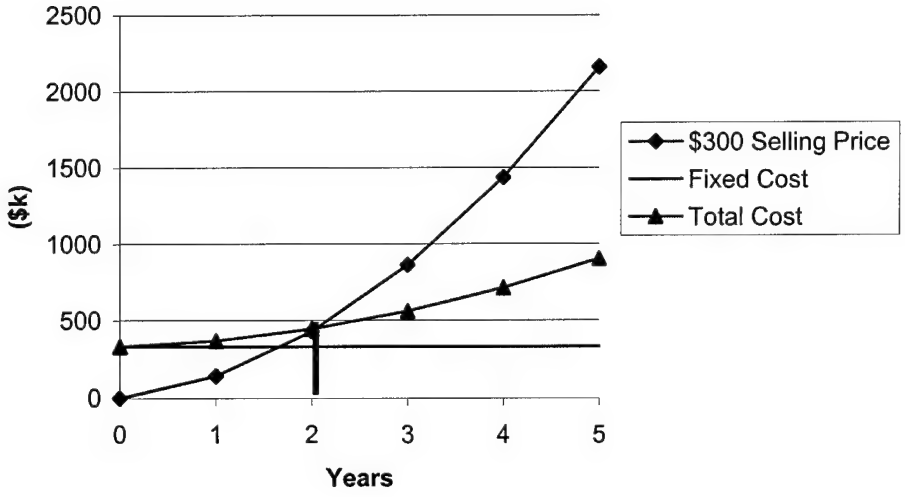

Figure 4: Break Even Time based on 2% Annual Growth

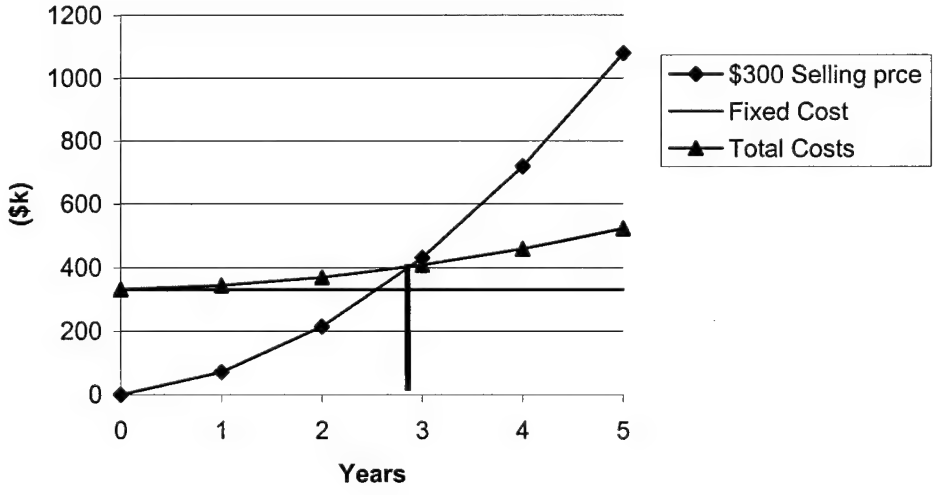

Figure 5: Break Even Time based on 4% Annual Growth

7.4 Results

Engineers preparing for the P.E. exam are only moderately price sensitive. Addtionally, if available P.E. distance learning courses are priced relatively high, the costs may be beyond the limit acceptable by engineers. Therefore, by maintaining the selling price of the product below the competitors, this new product will be more marketable. The current market price for a typical CD-ROM refresher course is approximately $500. By selling the product at $300 per unit, the expected sales growth will be greater than selling for a higher price. Additionally, a profit will be made from the product around 4 years after initial introduction.

8. CONCLUSIONS

Professional Engineer review courses can be effectively developed and delivered through means of a distance learning format. There is a market for a distance learning P.E. review course. Engineers preparing for the exam will consider purchasing a distance learning review class course. A survey conducted by the IES indicated that 88% of engineers in the State of North Carolina would purchase a distance learning refresher course. Of these engineers, 82% would purchase a combined CD-ROM and textbook refresher course.

Several distance learning options are currently available. The on-line/offline combined CD-ROM course developed by ASCE and marketed by Keepsmart Engineering was an excellent program and proved to be an adequate benchmark for IES for future course development.

Profession Engineer examinees are price sensitive and cost is an issue to be considered in course development. Most engineers would only pay up to $500 for a quality, comprehensive refresher course.

The overall evaluated course provided a very effective tool in reviewing for the P.E. exam and is recommended for any Civil Engineer preparing for the licensure exam. The course was very "user-friendly" and easily navigable. The screen layout and the ability to have the instructor explain how to complete the individual problem requirements were two benefits of this course.

9. RECOMMENDATIONS

A review of the ASCE refresher course content revealed several concepts and items that should be included and considered in developing a new course, such as:

- Ease of navigating through the course
- Comprehensive topical coverage
- Video and audio clips of instructors explaining the topic
- Explanation of the process involved in solving a problem
- Effective use of visual aides and graphics to fully explain the problem (i.e. Freebody diagrams)
- A diverse variety of problems
- Strong imbedded scientific calculator
- Quantitative feedback on problems
- Dedicated help line to answer basic questions

The cost analysis in section 7 included variable costs for required student help. To minimize this cost, it is recommended that an online bulletin board be established as the primary means of answering and asking questions. This would allow students to share solutions to practice problems and greatly reduce the direct interaction time of the instructor or IES personnel.

The designed length of the evaluated course was sufficient for the information given. However, the course could be lengthened without reducing the desirability of the course, by adding additional practice problems. Each individual module took between 4 and 10 hours to complete. This time was also determined to be adequate for reviewing a given section. Overall a new course should be designed to be completed in less than 100 hours, provided additional practice problems and the subject areas discussed below are included.

The evaluated course contained several video clips that displayed tests or demonstrated the theory behind the problem. Although graphics and diagrams are important in an Engineering class, these items can be removed from the review course. For example, video of how water flows through a pipe requires time to develop the graphic, but adds little to understanding the concept. Free-body diagrams that are not animated should still be used to explain the problem.

When explaining how to complete a problem, the process should be discussed prior to beginning the solution, similar to the structures module. This will help the student understand how to go about solving the problem and give the student an idea of how much work is involved to obtain the correct solution.

A new course should consist of the same 7 major topic areas that were covered in the evaluated course. In addition to the subject already covered under each module and as listed in Table 1, the subject matters listed in Table 5 should be added or discussed more in-depth. These items were identified in Reference 8, but were not directly covered in the refresher course.

The format used in presenting the material needs to be user friendly and easy to navigate. The example screens shown in Figures 1 and 2 are a good baseline for design. At any given time through the problem discussion, the student should be able to view the free-body diagram and the problem statement.

The tools section of the evaluated program was very useful. Specifically, the calculator allowed the program to stand-alone. However the imbedded calculator should be redesigned to handle multiple calculations at one time. As a recommendation, the calculator should be modified to provide a "( )" or similar function to allow for long strings of calculations to be entered. This recommendation is based on personal preference with using calculators and is partially substituted by the inclusion of a memory addition, subtraction, and storing capability.

As a follow-on to this project, and prior to designing a competitive product, a complete market analysis needs to be completed to identify the number of engineers throughout the country that have used refresher courses in the past and estimate the expected usage in the future.

Additionally, the expected selling price, revenue, and payback period should be identified to determine how effective a competitive course would be in the marketplace prior to beginning the development of a new course.

Table 5: Additional Subjects to be Discussed

	Add
Economics	Break Even Analysis
Geotechnical	More Discussion on Phase Diagrams
	Mohr's Circle review
	Surcharge Loading
Hydraulics and Hydrology	Review of Bernoulii's and Energy Equations
	Pumps and Turbine Efficiencies and Horsepower
	Reservoir Yield and Sizing
Structures	Stress / Strain Relationship Review
	Non-Cantilever Beams
	Indeterminate Structures
	Anchoring
	T-Beams
	Pre-Stressed / Post Tensioned
	Footings
	Different Connections (Welded, Bolted)
Sanitary Sewer and Environmental	More Discussion on Water Chemistry Calculations
Transportation	Roadway Banking Design
	Pavement Design
	Parking Design
Surveying	No Additions Recommended

An additional recommendation to justify the ratings assigned to each "learning" environment factor in the evaluated course, a separate survey should be performed on individuals that have participated in distance learning classes to determine the effectiveness of each factor. This survey should be completed prior to developing a new course to determine the course's marketability.

10. REFERENCES

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APPENDIX A: COURSE WEBSITE REFERENCES

Training Organization	Method		Media	Web Site	POC Email
	On-Line	Offline			
Keep Smart	X	X	CD-ROM	www.keepsmartengineering.com	dianayorgan@keepsmart.com
NSPE		X	CD-ROM	www.nspe.com	custserv@nspe.org
Missouri	X		Online Chalkboard / Chat room	web.missouri.edu	atkinsonj@missouri.edu
The Passing Zone	X		Online Chalkboard	www.ppi2pass.com/thepassingzone	
ENSYS	X	X	Live Internet	www.ensys.net	faisal@ensys.net
PERC	X	X	Self Paced Text	www.percinc.com	percinc@earthlink.net
University of Wisconsin		X	Self Paced Text	learn.wisconsin.edu/Students/Catalogs/Information	lang@learn.uwsa.edu
Red Vector		X	Various	www.redvector.com	livegrouphosts@redvector.com
MGI		X	Self Paced Text	www.mgi.org	mgiusa@aol.com
Great Lakes Press		X	Video Tape	www.glpbooks.com/glp	custserv@glpbooks.com
Learnon		X	Video Tape	www.learnon.org	learnon@asee.org
Auburn University		X	Video Tape	www.eng.auburn.edu/department/eesv/EPD	
North Carolina State University		X	Video Tape	claudia_baker@ncsu.edu	www.ies.ncsu.edu

APPENDIX B-1: PRIMARY DISTANCE LEARNING COURSE EVALUATION FACTORS AND RANKINGS

Form / Delivery Method / Content	Weight Factor	Economics	Geotechnical	Hydraulics & Hydrology	Structures	Sanitary and Environmental	Transportation	Surveying
Face-to-Face contact between students and teachers	6	50%	50%	50%	50%	50%	50%	50%
Instructor speaks clearly and slowly	6	100%	100%	100%	100%	100%	100%	100%
Fundamental concepts reviewed and explained	*6*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Effective use of visual aids (informative, legible, applicable to subject matter)	6	100%	100%	100%	100%	100%	100%	100%
Technical terms clearly identified	6	100%	100%	100%	100%	100%	100%	100%
Course Content is comprehensive	*5*	*90%*	*100%*	*90%*	*70%*	*100%*	*90%*	*100%*
Course covers all major topic areas	*5*	*90%*	*100%*	*100%*	*100%*	*90%*	*90%*	*100%*
Course ties all major topic areas together	*5*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Feedback is analytical, suggestive, and timely (not just provisions of the right answers)	*5*	*50%*	*70%*	*70%*	*70%*	*70%*	*50%*	*80%*
Ability to see and hear the instructor	4	80%	80%	80%	80%	80%	80%	80%
Active participation by the learner vs passively listening to lectures	4	50%	50%	50%	50%	50%	50%	50%
Written text provided that supplements course lectures	4	80%	80%	80%	80%	80%	80%	80%
References provided for more topic information	4	100%	100%	100%	100%	100%	100%	100%
Internal emphasis focusing on how instructional material relates to everyday reality	*4*	*50%*	*50%*	*50%*	*50%*	*50%*	*50%*	*50%*
Concepts are presented in a variety of contexts and expressed in a variety of ways	*4*	*50%*	*50%*	*50%*	*50%*	*50%*	*50%*	*50%*

APPENDIX B-2: SUPPLEMENTARY "IDEAL" COURSE EVALUATION FACTORS

Form / Delivery Method / Content	Weight Factor	Economics	Geotechnical	Hydraulics & Hydrology	Structures	Sanitary and Environmental	Transportation	Surveying
Provides students with the ability to verbally express ideas and discuss problems with peers and teachers	3	20%	20%	20%	20%	20%	20%	20%
Promote Group learning	3	0%	0%	0%	0%	0%	0%	0%
Course provides challenging, but attainable learning tasks	*3*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Problem presents more information than necessary to allow student decide which information is relevant	*3*	*80%*	*100%*	*80%*	*80%*	*80%*	*80%*	*80%*
Course material presented in a manner that increases students self confidence (start with simple concepts before introducing new ones)	3	100%	100%	100%	100%	100%	100%	100%
Problems requires students to make logical assumptions	3	100%	100%	100%	100%	100%	100%	100%
Problems requires students to think critically and analyze information	3	100%	100%	100%	100%	100%	100%	100%
Student provided with a "hands-on" model	2	0%	0%	0%	0%	0%	0%	0%
Student discussion of relevant P.E. experiences	2	0%	0%	0%	0%	0%	0%	0%
Introduction poses questions that are interesting and familiar to the student	1	50%	50%	50%	50%	50%	50%	50%
Form / Delivery Total	100%	75%	78%	77%	76%	77%	75%	78%

Note: Rows in Italics represent "content" factors. All other rows represent "delivery" factors.

APPENDIX C: COMPARISON OF PRODUCT FEATURES

Training Organization	Type of Course	Cost	# Hours / lessons of Instruction	Class Duration	Available Help with Problems	Knowledge of Specific P.E. Exam Contents **	Retake Guarantee	Total
Weight Factors*	(20)	(10)	(10)	(15)	(20)	(15)	(10)	(100)
Keep Smart (W/ ASCE & NSPE)	**CD-ROM or Online** *(20)*	**$595 or $249 / module ($495 for ASCE members)** *(5)*	**7 lessons 50 hours** *(8)*	**50 hours** *(15)*	**Full Motion Video of Problem Solution / Or email questions to central point** *(10)*	**Yes** *(15)*	**Yes - CD-ROM, use as much as needed** *(10)*	**83**
Missouri	**Online Chalkboard / Chat room** *(15)*	**$595** *(5)*	**8 lessons Self-Paced** *(8)*	**3 months** *(15)*	**Questions posted to an online white board.** *(15)*	**Yes** *(10)*	**Yes - you get to enroll in same class next year** *(10)*	**78**
ENSYS	**Live Internet** *(15)*	**$1,645** *(2)*	**500 – 600 2 - Seven hours sessions / week** *(10)*	**6 months** *(10)*	**Yes – Live** *(20)*	**Yes** *(10)*	**Yes - Free Retake** *(10)*	**77**
The Passing Zone	**Online Chalkboard** *(15)*	**$75** *(10)*	**Self-Paced** *(5)*	**~ 4 months** *(15)*	**Questions posted to an online white board.** *(15)*	**No** *(0)*	**No** *(0)*	**60**
MGI	**Self Paced Text** *(5)*	**$379.95 or $353.95 for members** *(7)*	**N/A** *(0)*	**N/A** *(0)*	**Assigned Personal Instructor** *(15)*	**Yes** (15)	**Money Back Guarantee if not passed w/in 1 year** *(10)*	**52**
Amazon.com	**CD-ROM / Book** *(20)*	**$90** *(10)*	**7 lessons** *(8)*	**Varies** *(0)*	**None** *(0)*	**Yes** (10)	**No** *(0)*	**48**
University of Wisconsin	**Self Paced Text** *(5)*	**~ $420** *(7)*	**15 lessons** *(10)*	**1 Year** *(5)*	**Email to Instructor** *(10)*	**Yes** *(10)*	**No** *(0)*	**47**
Great Lakes Press	**Video Tape** *(15)*	**$595** *(5)*	**7 lessons** *(8)*	**N/A** *(0)*	**None** (0)	**Yes** (10)	**N/A** *(0)*	**38**
Auburn University	**Video Tape** *(15)*	**$100 - $300 / course** *(5)*	**3 - 6 hours / lesson** *(8)*	**Varies** *(0)*	**Email to Instructor** (10)	**No** (0)	**No** *(0)*	**38**
PERC	**Self Paced Text** *(5)*	**$125** *(10)*	**7 lessons** *(8)*	**N/A** *(0)*	**None** *(0)*	**Yes** *(10)*	**No** *(0)*	**33**
North Carolina State University	**Video Tape** *(15)*	**~$4,000 to purchase** *(0)*	**4 lessons** *(5)*	**Varies** *(0)*	**None** *(0)*	**Yes** (10)	**No** *(0)*	**30**
Learnon	**Video Tape** *(15)*	**Varies** *(0)*	**N/A** *(0)*	**N/A** *(0)*	**None** *(0)*	**No** (0)	**N/A** *(0)*	**15**

* Number across the top of the row shows maximum amount of points allowed for each major category. Numbers in the individual boxes represents the amount of point given for that specific area.

** Courses Sponsored by ASCE, NCEES, or NSPE received higher marks.